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(54) ANCHOR SYSTEM FOR FLOATING RIGS

(71) SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.

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(72) JOHANNES RUDOLF HOGERVORST
(74) SF

(57) Claim 1. A method of securing a tubular element to the bottom of a body of water, comprising lowering the tubular element from the water surface to the water bottom, removably mounting a pumping unit on the tubular element either before or after the lowering of the tubular element, closing the tubular element at the upper end, reducing the pressure within the tubular element by operating the pumping unit so as to cause the tubular element to penetrate into the water bottom to a desired depth, stopping the operation of the pumping unit, disconnecting the pumping unit from the tubular element, raising it to the water surface and recovering it.

The invention relates to a method for securing a tubular element to the bottom of a body of water and to apparatus for carrying out this method.

It is often desirable to secure a tubular element to the waterbottom in order to use it for the anchoring of various structures, such as for example floating drilling platforms, floating production platforms, floating tension leg platforms, various types of ships and single buoy mooring systems for loading and unloading tankers, or, for examples, for the staying by means of guy cables of various structures, such as for example a freestanding marine conductor.

For this purpose it is well known to drive piles, for example hollow steel piles, into the waterbottom by means of known underwater pile drivers. In deep water, the driving of piles into the seabottom in this known manner is however a difficult and expensive operation.

It is an object of the invention to provide a method and apparatus for securing a tubular element to the bottom of a body of water in a simple, quick and inexpensive manner.

Therefore the method according to the invention comprises lowering the tubular element from the water surface to the water bottom, removably mounting a pumping unit on the tubular element either before or after the lowering of the tubular element, closing the tubular element at the upper end, reducing the pressure within the tubular element by operating the pumping unit so as to cause the tubular element to penetrate into the water bottom to a desired depth, stopping the operation of the pumping unit, disconnecting the pumping unit from the tubular element, raising it to the water surface and recovering it.

An apparatus for carrying out this method comprises according to the invention, a tubular element which is adapted to be closed at the upper end and which is open at the lower end, a thin cutting edge at the lower end of the tubular element, a pumping unit for reducing the pressure within the tubular element, said pumping unit being removably mounted on the tubular element by means of a releasable coupling.

In a suitable embodiment of the invention the pumping unit is connected to the tubular element by means of a releasable coupling which is preferably adapted to be remotely controlled.

The invention will now be explained with reference to the drawings relating to some possible embodiments of the invention wherein

Figure 1 shows a side view of a first embodi-

ment of the apparatus according to the invention.

Figure 2 shows a top plan view of the apparatus according to figure 1.

Figure 3 shows the lowering of the apparatus to the bottom of a body of water.

Figure 4 shows the apparatus at the moment that it contacts the waterbottom.

Figure 5 shows the apparatus at the moment that the tubular element has penetrated about halfway into the waterbottom.

Figure 6 shows the apparatus at the moment that the tubular element has penetrated into the seabed to the desired depth.

Figure 7 shows a vertical cross-section of a second embodiment of the apparatus according to the invention.

Figure 8 shows in perspective the application of the tubular element according to the invention to a supply boat bow mooring system.

Figure 9 shows in perspective the application of the tubular element according to the invention to a system for anchoring a pipeline to a waterbottom.

The embodiment of the apparatus for carrying out the method according to the invention as shown in figures 1 to 6 is generally indicated by the reference numeral 1. A tubular element 2, for example made of steel, is closed at its upper end 3 by

means of a cap 4. The lower end 5 of the tubular element 2 is open and is provided with a cutting edge 6 which enables the tubular element 2 to penetrate into the bottom 7 of a body of water 8.

The cap 4 is provided with a piece of pipe 9 and a pumping unit 10 is connected by means of a releasable coupling 11 to the upper end of the piece of pipe 9. The lower end of the piece of pipe 9 is provided with a sieve cap 19 for preventing ground material from reaching the pumping unit. The releasable coupling 11 can be a conventional remotely controlled releasable coupling (for example mechanically, hydraulically, pneumatically or electrically controlled or controlled by a combination thereof).

The pumping unit 10 is provided with two radial hollow arms 12, each arm 12 carrying a sheave 13 respectively 14, and each sheave being rotatable around a corresponding axis 15, respectively 16, and cooperating with a hoisting cable or -chain 26. Within the left hand hollow arm 12 a pump (not shown) is arranged and within the right hand arm 12 an electric motor (not shown) is arranged for driving the pump.

Furthermore the pumping unit 10 is provided with two air release valves 17, respectively 18. The valves 17 and 18 are so arranged that they can open or close a communication between the interior 20 and

the exterior of the tubular element 2. These valves 17 and 18 are conventional remotely controlled valves (for example hydraulically, pneumatically or electrically controlled).

The outer surface of the tubular element 2 is provided with a radial member 22 which carries a universal joint 23 for connecting an anchor line 24 to the tubular element 2. An umbilical cable 27 is connected to the pumping unit 10 in the manner shown in the drawings. The discharge of the pump is indicated by reference numeral 30 and is provided with a suitable one-way valve 28.

The installation of the tubular element 2 is carried out as follows.

From a vessel 28 the apparatus 1 is lowered by means of a hoist 29 which is provided with a hoisting cable or -chain 26. For this purpose the hoisting cable 26 is passed along the sheaves 13 and 14 and by gradually paying out the hoisting cable 26, the apparatus 1 is lowered to the bottom 7 (see figure 3). Before lowering the apparatus 1 to the bottom 7, the air release valves 17 and 18 are opened so that air can escape from the interior 20 of the tubular element 2 during the lowering operation.

When the cutting edge 6 contacts the bottom 7 (see figure 4), the hoisting line 26 is slackened

somewhat so as to allow the cutting edge 6 to penetrate into the bottom 7 over a small distance under the weight of the tubular element 2 and of the pumping unit 10, in order to form a seal around the base of the tubular element 1.

Then the air release valves 17 and 18 are closed and the pumping unit 10 is started from the vessel 28 by means of the umbilical cable 27, which causes the pumping unit 10 to evacuate water from the interior 20 of the tubular element 2, so that the pressure within the tubular element 2 is reduced. The pumping unit 10 evacuates the water from the interior 20 via the pipe piece 9, which acts as a suction conduit and discharges the water to the exterior of the apparatus 1 via the outlet or discharge 30. In this manner a pressure difference is created between the outside and the interior of the apparatus 1. This pressure difference causes a gradual penetration of the tubular element 2 into the bottom 7 (see figure 5) until it has reached the final position as shown in figure 6.

When the tubular element 2 has reached the desired final position, which can for example be detected by means of an underwater television camera (not shown) or by means of an echo-sounder (not shown), the pumping unit 10 is switched off and then

the necessary steps are taken for recovering the pumping unit 10.

For this purpose, the air release valves 17 and 18 and the releasable coupling 11 are operated by remote control via the umbilical cable 27, so that the valves 17 and 18 are opened and the pumping unit 10 is disconnected from the piece of pipe 9. Then the pumping unit 10 is raised to the water surface by hauling in the hoisting line 26 and taken aboard of the vessel 28 (see figure 6).

It is desirable to maintain the umbilical cable 27 and the anchor line 24 under tension during the lowering of the apparatus 1 to the waterbottom 7 to prevent tangling of the cable 27 and the line 24.

The pumping unit 10 is preferably provided with a water-tight container 21 accommodating suitable measuring equipment such as an inclinometer, a differential pressure gauge and an echo-sounder or television camera to register the penetration depth of tubular element 2. By means of those instruments the progress of the installation operation can be watched and corrections can be made, if necessary.

After the installation of the tubular element 2, the anchor cable 24 can be used for mooring a floating object, for example, a vessel or a floating platform, to the tubular element 2.

Another embodiment of the apparatus according to the invention is shown in figure 7.

This embodiment comprises a tubular element or pile 35, preferably made of steel. The lower end 36 of the pile 35 is open and is provided with a cutting edge 37. The tubular element 35 is furthermore provided with a radial flange 38 which is reinforced by radial webs 39. A pumping unit generally indicated by reference numeral 40 is adapted to be placed onto the top end of the tubular element 35. A sealing ring 41 is present so that a liquid tight seal can be obtained between the tubular element 35 and the pumping unit 40. The pumping unit 10 comprises a hollow main body 42 carrying two pumps 43 respectively 44, each having an outlet 45, respectively 46. Within the main body 42, compartments 47 and 48 are present. These compartments are in communication with the pumps 43, respectively 44. A communication exists between the interior 50 of the tubular element 35 and the compartment 47 via a channel 51 and an annular filter 52. Similarly a communication exists between the interior 50 and the compartment 48 via a channel 53 and an annular filter 54. Valves 55, respectively 56, are arranged at the end of channel 51, respectively channel 53. These valves are preferably remotely controlled, so that

they can be opened or closed at will from a vessel at the watersurface. For this purpose suitable electric cables 60 respectively 61 lead from the valve 55 respectively 56 to the said vessel. Electric cables 62 respectively 63 lead from the pumps 43 respectively 44 to the vessel at the watersurface in order to switch the pumps 43 and 44 on and off as required.

Within the tubular element 34 radial webs 64 and 65 are present which carry an eye 66 which is centrally arranged within the tubular element. A first hoisting cable 67 is secured to the eye 66. An annular guide element 72 is arranged around the hoisting cable 67. Hoisting cables 68 and 69 are secured respectively to eyes 70 and 71 on the pump unit 40. The electric cables 60 and 62 are secured to or incorporated into the hoisting cable 68 and the electric cables 61 and 63 are secured to or incorporated into hoisting cable 69.

The apparatus according to figure 7 is installed as follows.

By means of the hoisting cable 67 the tubular element 35 is lowered from a vessel to the waterbottom. When the tubular element 35 has reached the waterbottom the cable 67 is slackened somewhat, in order to allow the cutting edge 37 to penetrate into

the waterbottom under the weight of the tubular element 35. Then the valves 55 and 56 are opened and the pump unit 40 is lowered from the vessel by means of the cables 68 and 69 until the pump unit 40 reaches the position as shown in figure 7. During the lowering of the pump unit 40 the guide element 72 slides along the cable 67 which is kept in stretched condition during the lowering of the pump unit 40.

The remotely controlled valves 55 and 56 are then closed from the vessel by passing a proper signal and the necessary energy via the electric cables to the valves 55 and 56. After closure of the valves 55 and 56 the pumps 43 and/or 44 are switched on by passing a proper signal and the necessary energy through the electric cables 62 and/or 63. The pump(s) 43 and/or 44 remove water from the interior 50 of the tubular element 35 which is discharged through the outlet(s) 45 and/or 46. In this manner a pressure difference is created between the interior 50 and the exterior of the tubular element 35 which causes the latter to penetrate into the waterbottom.

When the tubular element 35 has penetrated into the waterbottom to the desired depth, the pumps 43 and/or 44 are switched off and the valves 55 and 56 are opened again. Then by means of the hoisting cables 68 and 69 the pumping unit 40 is raised to

the watersurface and taken aboard of the vessel. If desired the cable 67 can then be used for mooring a floating object such as a vessel or a floating platform to the tubular element 35.

In the above, the tubular element 35 is lowered to the waterbottom before the lowering of the pumping unit 40. Instead, it is possible to lower the tubular element 35 and the pumping unit 40 together at the same time.

A tubular element, secured to the bottom of a body of water in the manner according to the invention can be used for various purposes. If it is provided with an anchor cable, it can for example be used for the mooring of a ship, for anchoring a floating production- or drilling platform, so as for example a so-called tension leg platform, for anchoring a single buoy mooring system for loading or unloading tankers.

The said tubular element can also be used as an envelope for protecting the wellhead and/or the upper part of an oil- or gaswell in the seabed, or for anchoring a pipeline to the seabed, or for the staying by means of guy cables of various structures, such as for example a freestanding marine conductor.

An example of a possible application of the apparatus according to the invention is shown in

figure 8, which discloses a bow mooring system for mooring a supply boat 80 close to an offshore drilling platform 81. In this figure, a tubular element 82, secured to the seabottom 83 in the manner according to the invention, is used for anchoring an intermediate buoy 84 below the watersurface 85 by means of a chain or cable 86, which interconnects the tubular element 82 and the intermediate buoy 84. A mooring buoy 87 floating at the watersurface 85 is connected to the intermediate buoy 84 by means of a cable or chain 88. The mooring buoy 87 is provided with a mooring line 88 which is adapted to be connected to the mooring hawser 89 of the supply boat 80. The stern of the boat 80 is connected to the platform 81 by means of a pair of mooring lines 90 and 91.

Another field of application of the invention concerns the anchoring of a pipeline to the seabed in the manner as shown in figure 9. In figure 9, a pipeline 90 is shown which is laying on the seabed 91. In order to anchor the pipeline 90 to the seabed 91 a brace 92 is placed over the pipeline 91. At each end the brace 92 is provided with a bore 93 and a jacket 94. The brace 92 is secured to the seabed by passing through each bore 93 and jacket 94 a tubular element 95 according to the invention. This

tubular element 95 is provided with a collar 96 and it is installed and caused to penetrate into the seabed 91 in the manner according to the invention as described in the above.

The jacket 94 is internally provided with a cam 97 which is adapted to cooperate with the collar 96 on the tubular element 95.

Figure 9 shows the situation after both tubular elements 95 have been installed. The tubular elements 95 anchor the brace 92, firmly to the seabed 91, so that the brace 92 secures the pipeline 90 firmly to the seabed 91. The purpose of the cam 97 is to load the tubular element 95 eccentrically when an upwardly directed force acts on the pipeline 90 and thus on the brace 92.

After the tubular elements 95 have been installed the pumping unit (not shown) of each tubular element 95 is raised to the watersurface and recovered in the manner as explained in the above.

If it is desired to remove the tubular unit from the seabed, it is possible to secure a pumping unit to the tubular element and to create an overpressure within the tubular element causing the tubular element to raise upwardly so that it can be recovered.

The pump used in the pumping unit according to the invention can be of any suitable type, for ex-

ample a centrifugal pump, a positive displacement pump, or even an ejector pump.

The claims defining the invention are as follows:

1. A method of securing a tubular element to the bottom of a body of water, comprising lowering the tubular element from the water surface to the water bottom, removably mounting a pumping unit on the tubular element either before or after the lowering of the tubular element, closing the tubular element at the upper end, reducing the pressure within the tubular element by operating the pumping unit so as to cause the tubular element to penetrate into the water bottom to a desired depth, stopping the operation of the pumping unit, disconnecting the pumping unit from the tubular element, raising it to the water surface and recovering it.

2. An apparatus for carrying out the method as claimed in claim 1, comprising a tubular element which is adapted to be closed at the upper end and which is open at the lower end, a thin cutting edge at the lower end of the tubular element, a pumping unit for reducing the pressure within the tubular element, said pumping unit being removably mounted on the tubular element by means of a releasable coupling.

3. The apparatus as claimed in claim 2, wherein the releasable coupling is adapted to be remotely controlled.

4. The apparatus as claimed in any one of the claims 2-3, wherein the apparatus further comprises a valve for opening or closing a passage between the interior and the exterior of the tubular element.

5. The apparatus as claimed in claim 4, wherein the valve is arranged on the pumping unit.

6. The apparatus as claimd in the claims 4 or 5, wherein the valve is adapted to be remotely controlled.

7. The apparatus as claimed in any one of the claims 2 to 6, wherein the apparatus further comprises hoisting means for lowering or raising the apparatus.

8. The apparatus as claimed in claim 7, wherein the hoisting means are connected to the pumping unit.

9. The apparatus as claimed in any one of the claims 2 to 8, wherein the pumping unit is provided with a filter- or sieve device.

10. The apparatus as claimed in any one of the claims 2 to 9, wherein the pumping unit is adapted to be remotely controlled.

11. The apparatus as claimed in any one of the claims 2 to 10, wherein the pumping unit is provided with a water-tight container which accommodates measuring equipment.

12. The apparatus as claimed in any one of the claims 2 to 11, wherein the tubular element is provided with an anchor line.

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SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.

Patent Attorneys for the Applicant

SPRUSON & FERGUSON

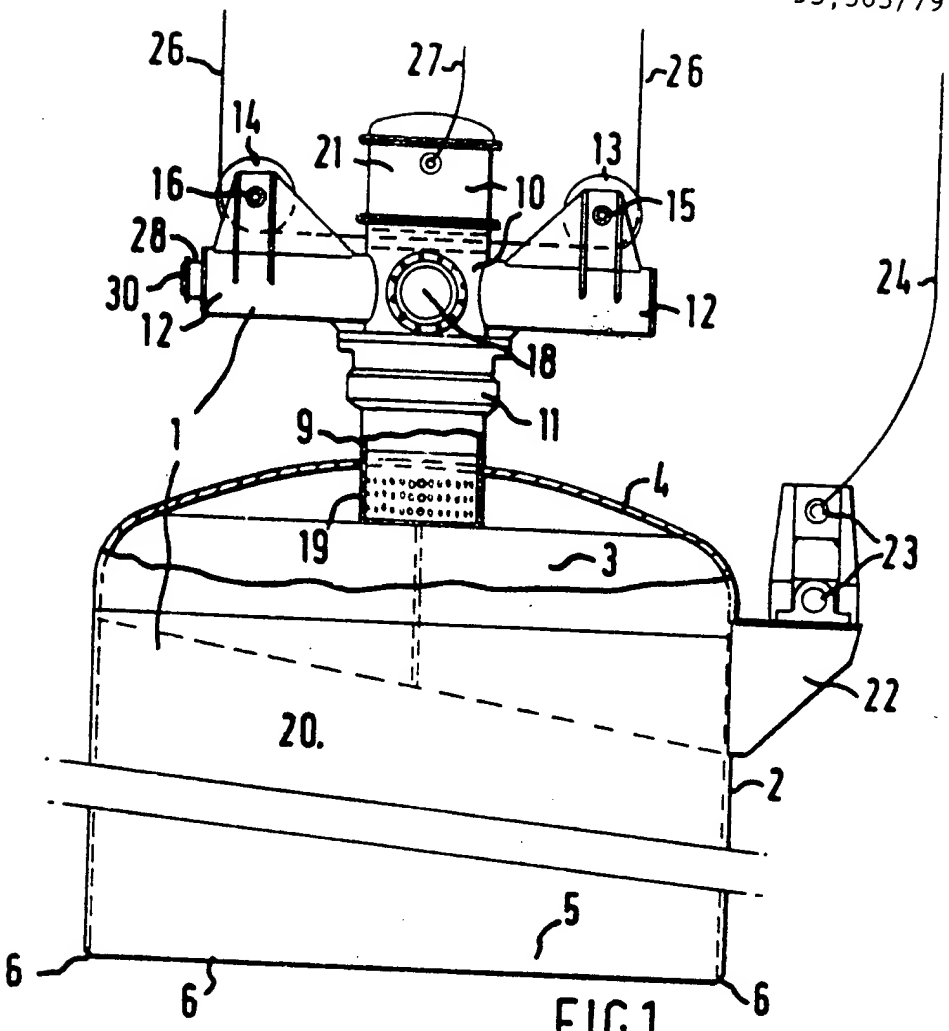
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FIG.1

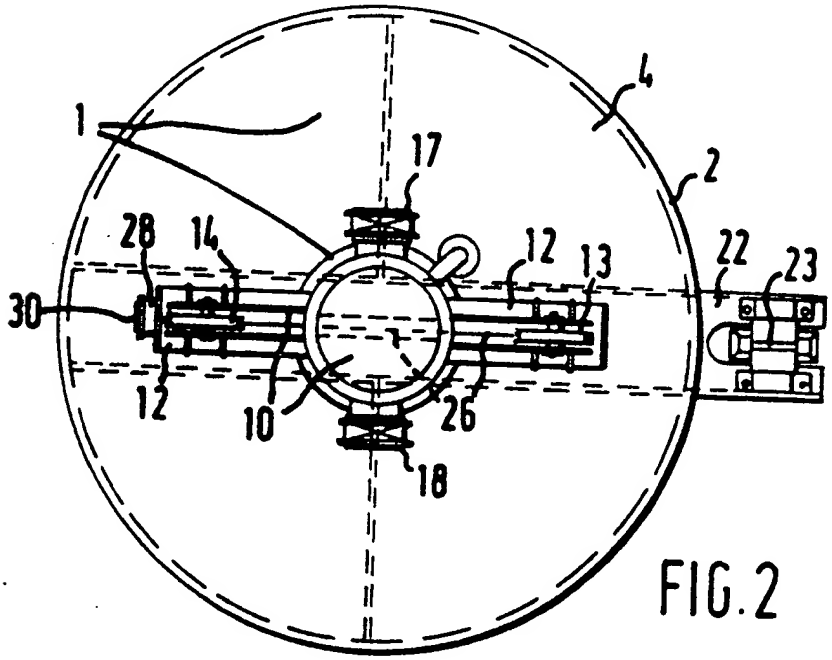
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FIG.2

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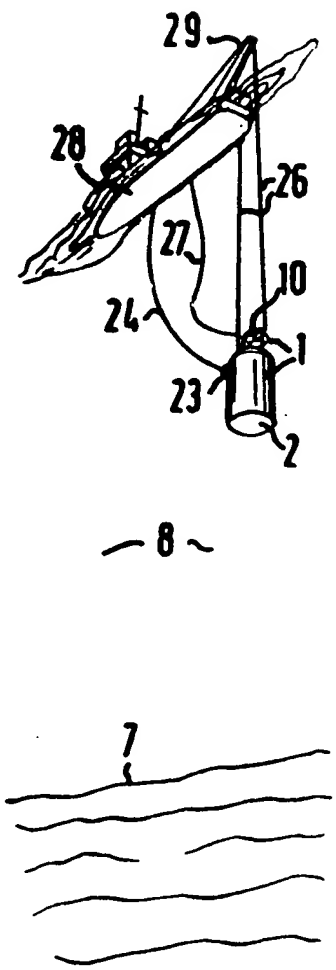

FIG.3

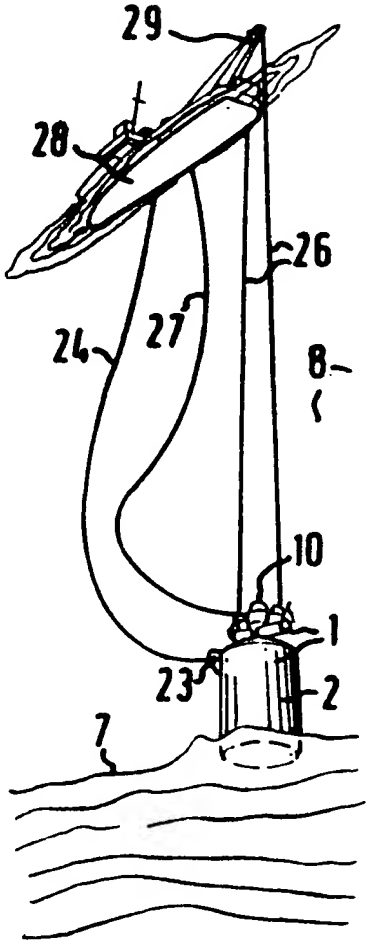

FIG.4

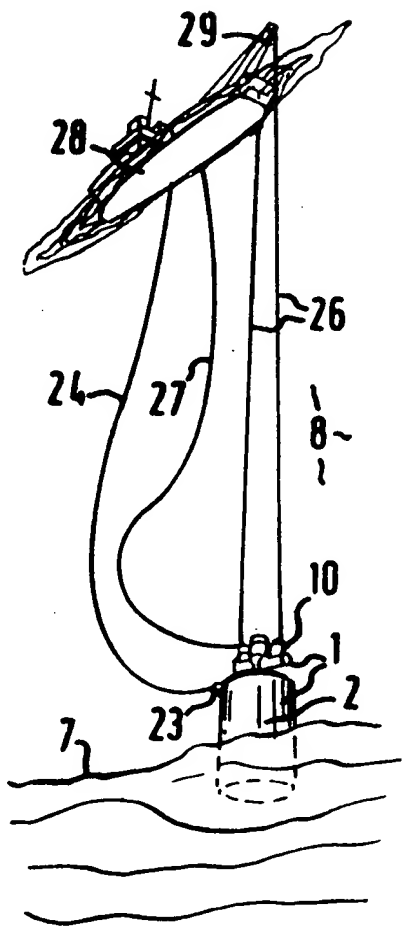

FIG.5

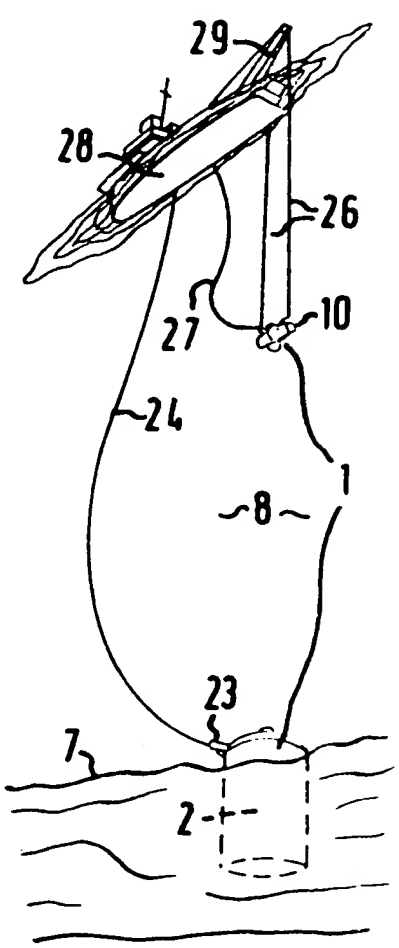

FIG.6

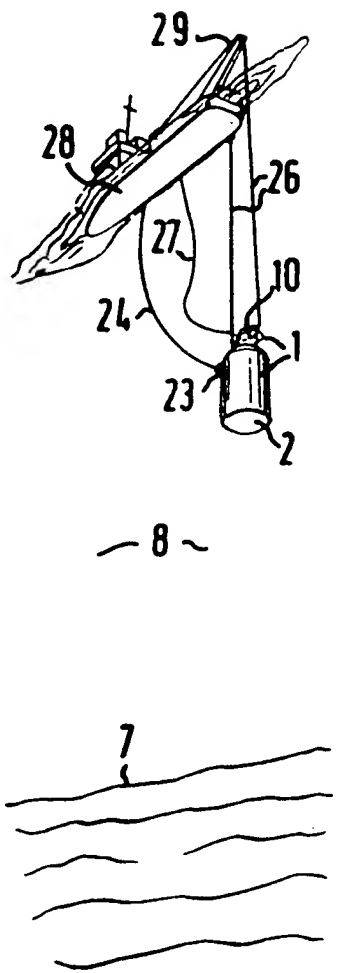

FIG.3

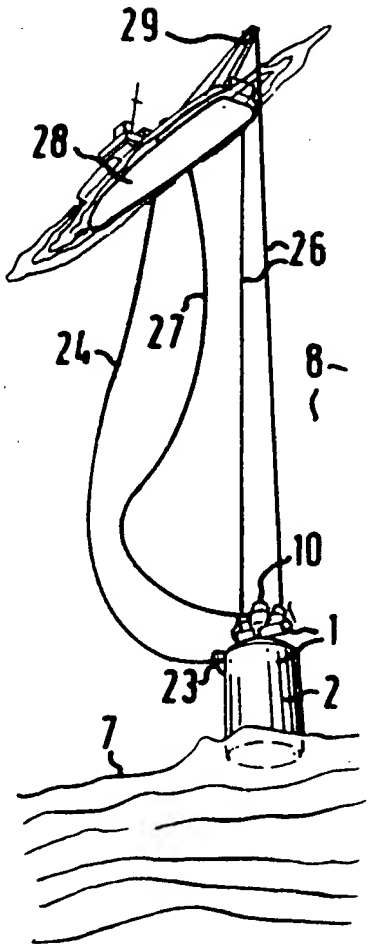

FIG.4

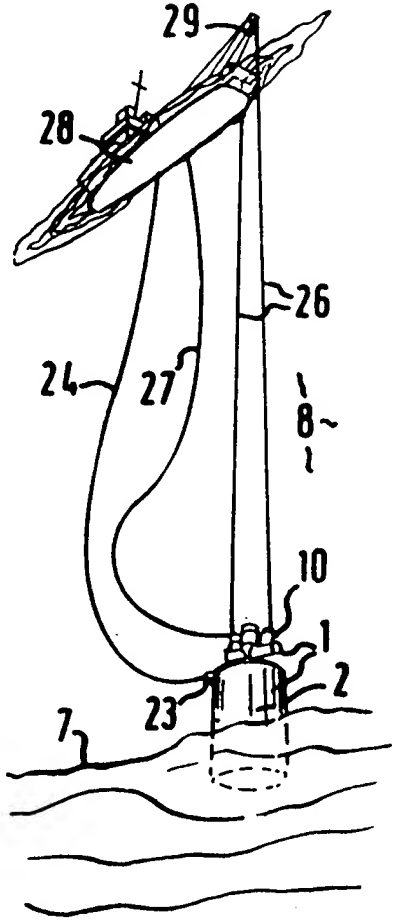

FIG.5

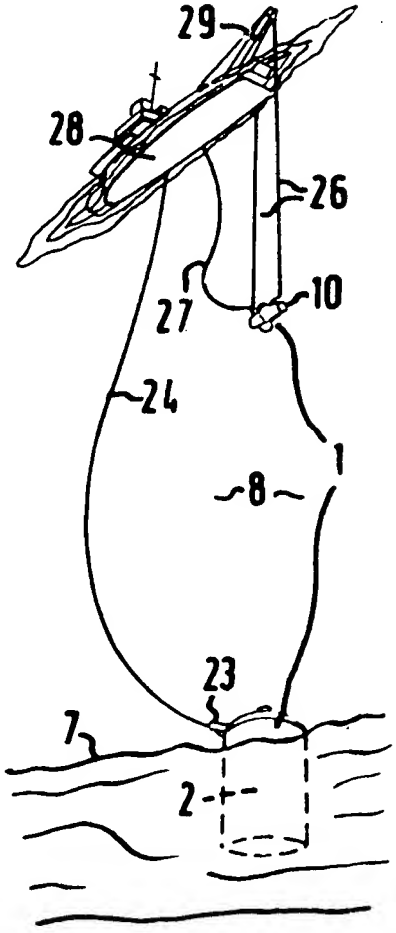

FIG.6

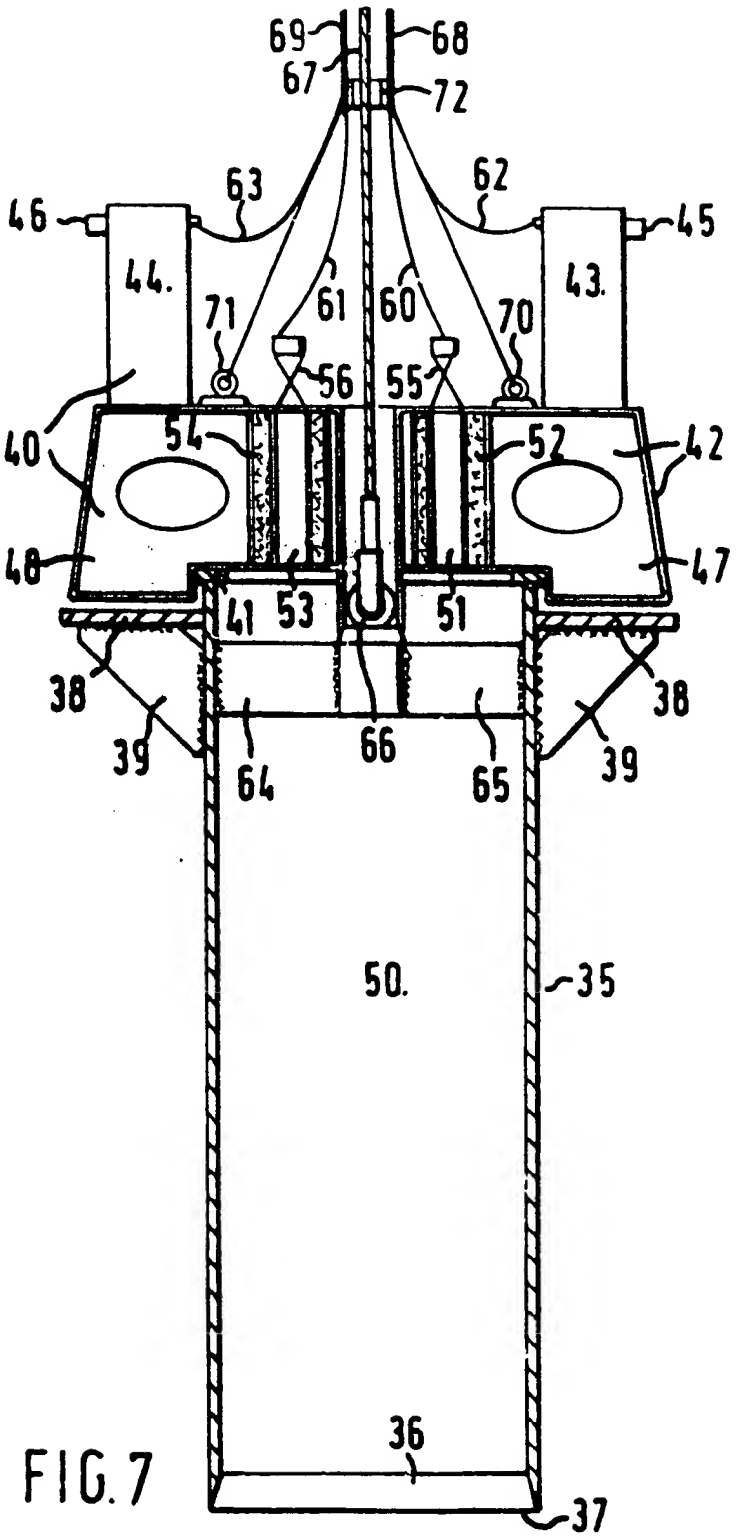

FIG. 7

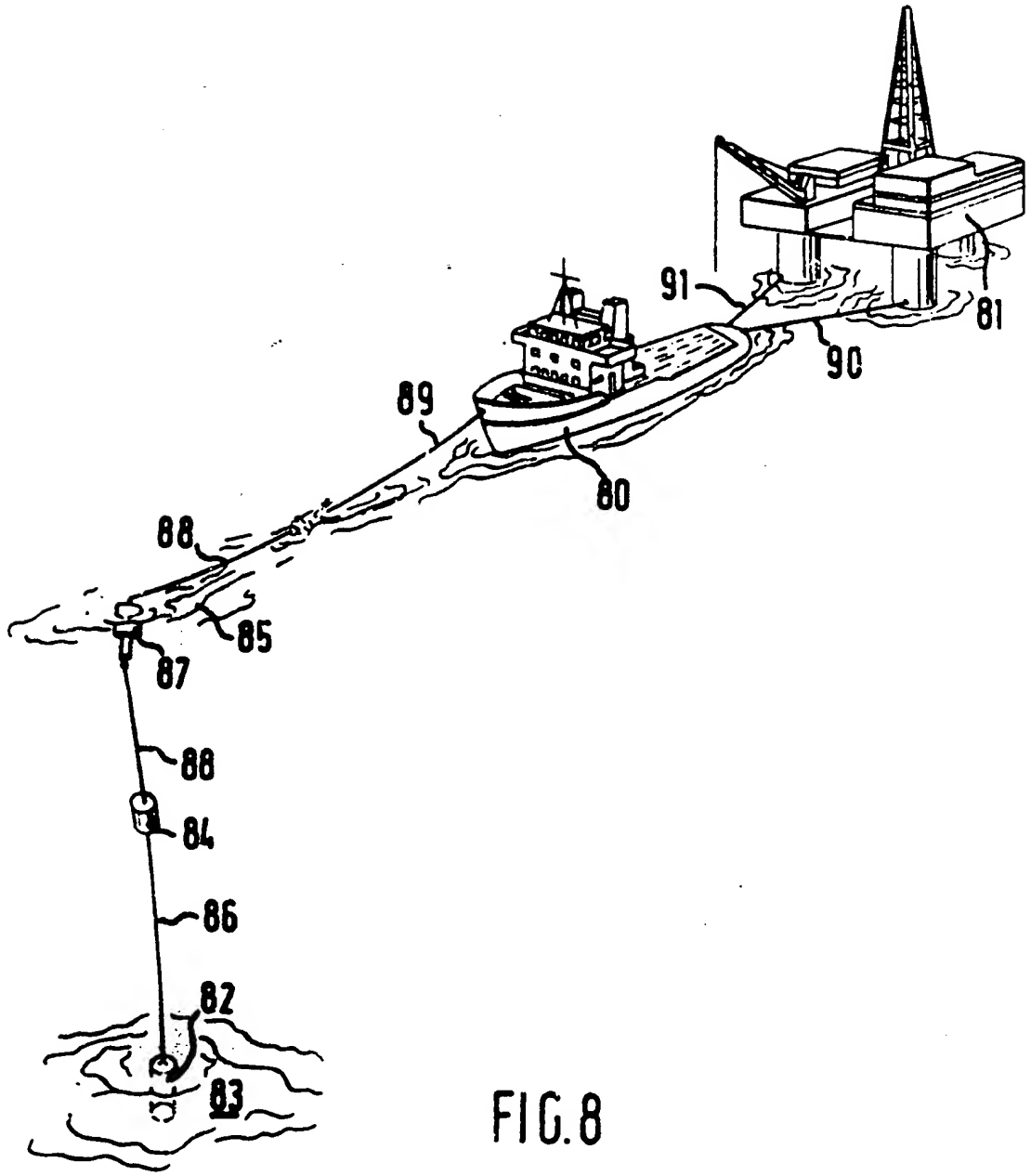

FIG.8

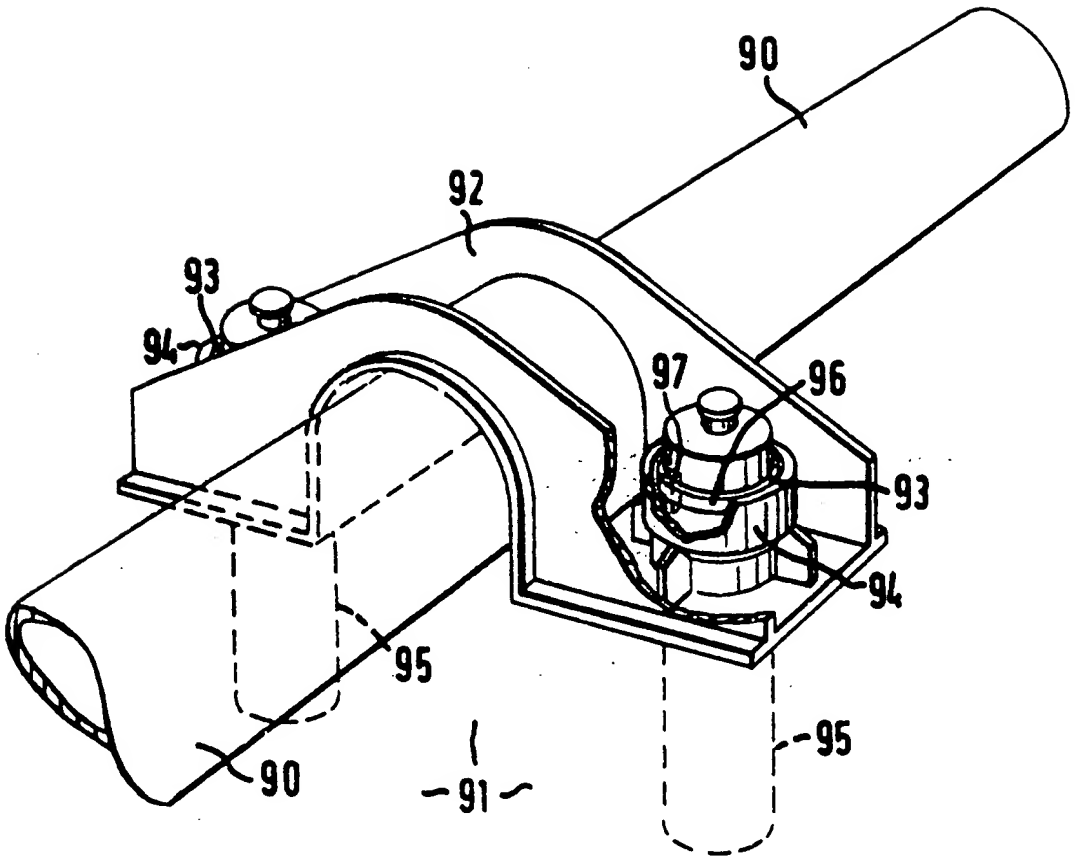

FIG.9